The Role of the Minerals in Nutrition.

Radio Talk, KUSD NOv. 13, 1935 E.H. Shaw Jr.

The mineral needs of ~~h~~ man are a part of his evolutionary inheritance. Four hundred million years ago, the evolutionary ancestors of man swam in the Cretaceous Sea and crawled in the primeval slime. At that time, the blood and other body fluids of our lowly ancestor were in equilibrium with the surrounding salt water and contained the various salts and mineral elements in the same concentration as the surrounding sea water. Since the body is very sensitive to changes in salt concentration, the survival of the first primitive form to venture on dry land depended on his ability to maintain this normal concentration of salts in the blood and other body fluids. Our evolutionary ancestor solved this problem and transmitted this power of maintaining the normal concentration of ~~s~~ salts in the blood as an hereditary characteristic to his offspring This was so successful, that even at this late date, 400,000,000 years later, we still carry in our blood stream a miniature model of the cretaceous sea, our homeland, in the same way that emigrants frequently carry to their new homes a bit of the soil of their native country.

Although we are now fully adapted to life on dry land, perhaps some of us wish it were not so dry year after year and would welcome an little more moisture. As a matter~~s~~ of fact, we are not completely adapted to life on the land, but each and every one of us still treasures the memory of the free and easy life in the ocean. During our prenatal life, we grow and develop in a fluid enviornment a tiny bit of the cretaceous sea stored up within the placental membranes, and during these months we relive our evolutionary history, going through all the changes between an aquatic animal and a land animal,

following in a rapid transition the slow and tedious path ~~of~~ our prehistoric ancestors traveled, to emerge at last on dry land at the highest level of creation, the supreme handiwork of the Creator. But even at this high stage in our depelopment, we still carry some traces of our ancestral aquatic environment. Our inner ear is still filled with some of the fluid from the cretaceous sea, and is better adapted for hearing under water than in air. Our need for mineral elements is identical with that of our early cretaceous ancestor. In a changing world, after 400,000,000 years some of these minerals are not so easily available to us as they were to our prehistoric ancestor. We still need the same minerals but do not have available the same abundant supply. Let us con-some of these minerals individually.

Calcium, or lime, is the material from which our bones and teeth are formed. It is also important in the functioning of the heart, muscles and internal organs. The blood contains 0.01% of this valuable element, and, if the concentration of calcium in blood should fall to 0.006%, death in convulsions occurs.

Many different substances have been used to form the supporting structures of various living forms. Cellulose, a~~n~~ carbohydrate substance, formed from water and carbon dioxide gas, is used as a structural component by plants. It may also be formed from the carbohydrate or sugar foodstuffs which are so abundant in the plant world. Had our evolutionary ancestor selected this as a source of material for the structural unit of the skeleton, we would always have had an abundant supply of building material for our bones. Chitin, a compound similar to cellulose, but containing nitrogen, is used by fungi, insects, and some shell fish as a building material for the firmer structures of their bodies.

This material is one of the most durable building materials used by living forms, fungus spores having been found hundreds of million years old, with the chitin envelope still unchanged. Everyone is familiar with the ease of preservation of insect specimens in the museum, a further indication of the durability of this material. Chitin may be formed from nitrogenous materials and carbohydrates and since these materials are esential to life and are abundantly distributed in the world about us, there would never have been a shortage of supply had our primeval ancestor elected to use this as a structural material for the skeleton.

Silica, the material of sand, which is so abundant in the world is used as skeletal material by many microscopic forms, and is as permenant as the rocks, but ~~is~~ it is only slightly soluble, and was not available in sufficient amount to tempt our cretacean ancestor to us it as a skeletal building materal. Calcium and magnesium phosphate or carbonate have been used as the structural unit by many forms of animals, fish and shellfish, as well as by microscopic organisms. Of these compounds, calcium phosphate is the most insoluble and therefore the most permanent skeletal material, and was developed as a skeleton by our evolutionary ancestor. Calcium was more abundant in the days of our evolutionary ancestor than it is now. In the 400,000,000 years that have passed, calcium has become scarcer. Billions of tons of lime have been used to form skeletons, which, when the animals died, have only very slowly weathered and gotten back into the calcium cycle of nature. Enormous deposits of limestone, chalk and phosphate rock, are formed entirely of the skeletons of marine animals. This great amount of calcium is largely withdrawn from circulation, and only slowly finds its way back into solution, and into those plant and animal foods that are the necessary sources of this vital food element for man.

Calcium at the present day is scarce in food sources, and our bodies have not found a substitute for this element as a building material for bones. Evolution has made a partial adjustment to this scarcity of calcium by making our bony structures thinner and by eliminating some of the extra teeth; thereby decreasing our need for calcium. Even with these economies, the calcium supply is in danger of falling short of our needs.

From a study of calcium excretion in adults, Sherman has determined that the minimum requirement of calcium is 0.015 oz. per day for an adult and that a daily dietary allotment of 0.022 oz. is the normal dietary requirement. His findings showed that 52% of the dietaries in common use fell below this normal figure, and 16% fell below the absolute minimum for calcium intake. These figures readily suggest the reason for the great prevalence of dental disease in the United States. The dietary need for calcium in children and in women during pregnancy and lactation is considerably greater than the normal adult requirement. and should be fulfilled by a daily calcium ration of 0.03 to 0.04 oz. of calcium per day. Even when the calcium intake is normal it may be offset by excessive loss of calcium from the body. This excessive loss of calcium from the body is especially noticeable when insufficient amounts of Vitamin D are supplied, when excessive amounts of phosphate enter into the dietary, and in conditions where the intestinal contents become alkaline, resulting in the loss of calcium phosphate and calcium soaps in the feces.

Calcium shortage in the dietary, or excessive loss of calcium from the body, results in depletion of the calcium in the bones, with softening and malformation of the bones or manifest rickets, and in decay and loss of teeth.

These diseases may avoided when the dietary contains an abundance of calcium. Milk is the best source of food calcium, the daily need being supplied by 6 oz. of cottage cheese, 4 oz. of american cheese or 1 qt. of milk. Beans, nuts, cabbage, spinach, and asparagus are rich vegetable sources of this mineral, but the calcium from vegetable sources is not as well absorbed as that in milk. Calcium carbonate, lime water, and the calcium in drinking water are readily utilized, but should not be substituted for milk, which contains other valuable nutritive factors besides calcium.

Phosphorus, the other constituent of the calcium phosphate in bones, is utilized in the body for the formation of bones and teeth, for the building of tissue cells and for the regulation of the neutrality of the body. The phosphorus requirement is high, being twice that of calcium, or from 0.03 oz to 0.08 Oz per day, the higher values being required for children and pregnant or lactating women. In his statistical sudies, Sherman found that only 4% of the Americian dietaries were deficient in this valuable food element. The probability of deficiency of phosphorus in human nutrition is very slight, although it may be a limiting factor in animal husbandry. Excessive phosphorus in the human dietary should be avoided, or else balanced by ~~the~~ an increase in the calcium intake in order to avoid excessive loss of calcium from the body throught the alimentary tract. The most favorable ratio is 1 part of calcium to 2 parts of phosphorus. Among the richer sources of phosphorus are cheese, milk, egg yolk, beans, peas, bread, fish, meat, oatmeal, and barley. The phosphorus requirement may also be met by the use of inorganic phosphates which are readily utilized.

The magnesium requirement in the dietary is low, being not more than 0.01 oz per day, and this is present in foods in such a degree of abundance that magnesium has not been demonstrated to be a limit~~////~~-ing factor in human nutrition. Expermental animals deprived of magnesium in the dietary develope ~~a~~ severe reddening of the skin, increased irritability of the nervous system, heart disturbances and convulsions. Gross excess in dietary magnesium results in displacement of calcium from the body, but no serious pathological changes except kidney stones.

Iron in the dietary is required for the formation of hemoglobin in the blood, and on iron poor dietaries, anemia develops. The daily requ-irement for iron is 1/3,000 oz. This may be supplied in the form of food iron. The richest sources are the organ meats (liver, heart, kidney, spleen), meat, egg yolk, whole wheat, fish, nuts, dates, beans, spinach, and oatmeal. Milk is a very poor source of iron and if an an-imal's diet is restricted to milk for much longer than its normal lactation period, anemia may result. Raisins are a better monument to the eff-iciency of our advertising agencies than a source of dietary iron. To fulfil the daily requirement of iron would require 1 and one half lbs. of raisins. ~~//~~ The iron requirement may also be met by inorganic iron salts. This question was cleared up by Hart and Steen bock at the University of Wisconsin in 1928, who showed that the apparent inefficiency of inorganic iron as a blood building element was due to the shortage of copper in the purified expermental dietaries. Only traces of copper are necessary in the dietary, but this small amount of copper is re-quired in order that the body may form hemoglobin from the iron. This interesting relationship between iron and copper carries us back again to the evolutionary development of the race. Back 400,000,000 years in the Cretaceous Sea, some of the primitive forms carried a copper compound,

hemocyanin, in their blood in place of the iron compound, hemoglobin, that is present in most animals today. The animals that have the iron compound hemoglobin circulating in their blood, still must rely on the evolutionary progenitor, copper for the synthesis of hemoglobin. In support of this theory of the evolutionary significance of copper in nutrition ~~of the~~ is the fact that the copper content of the ~~body~~body is greatest in infancy and prenatal life and is least in the adult. The best food sources of copper are liver, oysters, cocoa, nuts, currants and peas.

Iodine is a absolute essential in the dietary although the daily requirement is small, 1/600,000 of an oz. In regions where the water and the soil are deficient in iodine, goiter is prevalent as in the great lakes States in this country and in Switzerland. Inorganic iodine compounds are well utilized so that the introduction of ~~i~~ iodized salt has very greatly decreased the incidence of goiter in this country. The need for iodine is a further example of our dependence on the sea and ~~of~~ the inheritance through 400,000,000 years of that dependence. The ocean is the great source of iodine, in fact iodine was formerly extracted in commercial quantities from sea weed In our search for dietary iodine, we are led back to the ocean that cradled our primordial ancestors, fish and oysters being the best food sources. The iodine content of vegetables is dependent on the iodine content of the soil in which the vegetables grow, so that a general statement of the food iodine content of these vegetables is not possible.

Hart and Elvehjem at Wisconsin in 1931 demonstrated the importance of manganese in maintaining the ~~normal~~ normal reproductive cycle in expermental rats, but this element is required in such minute amounts and is so widely distributed in plant foods, that it cannot become a limting factor in human nutrition.

Common salt is an essential in the dietary, 1/15 of an oz. being the minimum daily requirement. Since the daily intake is 1/2 oz. this is not a limiting factor, Salt is the major inorganic constituent of blood serum and helps regulate the neutrality of the body. Its loss from the body leads to dehydration and circulatory inefficiency with a resulting condition of easy fatigue. These cases develop a salt hunger which automatically results in the replacement of the salt content of the body. Great perspiration, and the development of acid or alkaline condition of the body results in the loss of salt from the body. The supplying of an~~d~~ abundance of salt hastens the restoration of these cases to the normal condition. Salt is the factor in the body fluids that most clearly records our early ancestral environment in the Cretaceous Sea. In the 400,000,000 ~~tons~~ years that have elapsed since our ancestors ventured on dry land the salt content of the ocean has almost tripled, but man and the other mammalian forms still carry the same salt content in the blood and other body fluids. An interesting example of the importance of salt was demonstrated in the early part of this century. Welsh miners in the deeper workings perspired freely and lost much more salt from their bodies than was being replaced in the dietary. Since the body cannot make blood without salt, the volume of the blood was decreased and the circulation of the blood become ~~is~~ inefficient, interfering with their capacity for work and frequently resulting in fainting or collapse while at work. The large amounts of water which they consumed resulted in the further loss of salt from the body. A small amount of salt added to the drinking water restored the salt content of the blood, increased the volume of the blood and the circulatory efficiency, and restored to these men the capacity for productive work.

Potash is an essential food mineral. In its absence there is growth failure and premature death. The potash content of the foods is so abundant, however, that this is never a limiting factor. Excessive potash in the dietary, especially noticable in the herbivorous animals leads to loss of salt from the body and salt hunger. Buffalo and deer travel long distances and brave many dangers in search of rock-salt deposits, or salt licks, The high potash content of the grasses which these animals were accustomed to eat resulted in depletion of their salt reserves and a consequent great salt hunger.

The minerals which are at the present of greatest importance in human nutrition are calcium and iron. The regular use of milk (1 pint to 1 qt per day) and of meat, eggs and the green vegetables will supply these valuable food elements in sufficient amount.

Although these foods are in the more expensive food classes, economy should not be allowed to eliminate them from the dietary.